AMATEUR WORK

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STUDIES IN ELECTRICITY.

Donald M. Bliss.

IV. Magnetism and Induction.

Having made the electromagnet and circuit closer, as described in the preceding article, and connected with the battery, it will be noticed that whenever a current is sent through the coils, by operating the circuit closer, the soft iron core will become a powerful magnet so long as the current continues to flow through the coils; but as soon as the circuit is opened or broken, the magnetism will as suddenly disappear. If the iron core is not very soft or thoroughly annealed, the magnetism will not disappear entirely with the loss of current, but will remain indefinitely. The strength and duration of such residual, or permanent magnetism as it is called, depends upon the degree of hardness and quality of iron used for the core. If hard steel be employed, the first instant the current flows through the coils it will become a permanent magnet, the strength of which may last for years. This may be easily demonstrated by removing the soft iron core and placing a piece of hard steel rod, an old file, or knitting needle in one of the coils and closing the circuit for an instant.

Before taking up the study of the principles embodied in this experiment, the following instructions for making permanent magnets with this apparatus may be noted.

If it is desired to magnetize small round or flat steel magnets from 3″ to 4″ long, leave the soft iron core in the coils, and magnetize by placing the magnets against the poles or ends of the core and closing the circuit for a few seconds. Do not remove the magnetized pieces from the poles while the current is on, but open the circuit first, then pull off the magnets. The reason for this is that if the piece is carelessly pulled off while the core is strongly magnetized, the magnet is liable to slide sideways, and weaken, or possibly reverse, the magnetism in the piece.

If the pieces to be magnetized are quite large or long, the best method is to take out the soft iron core entirely and insert one piece in each coil. Join the ends projecting beyond the coils by laying a piece of iron rod or strip across the ends. Then turn the current on and off a few times, finally opening the circuit and removing the pieces from the coil, when they will be found to be strongly magnetized. For small magnets, Stubbs steel wire or rod answers very well for some cases. Old files, or any piece of good tool steel, will answer most purposes, but it must be hard, not annealed.

The term "poles" invariably applied to a magnet, whether under the action of a current or permanent, is used because the two ends of such a magnet are always attracted towards the earth's north and south poles. Of course, the magnet, as a whole, cannot move towards such a direction unless it is of the proper form and free to move, as in the case of a compass needle. To demonstrate this, magnetize an ordinary sewing needle, stick it through a bit of cork and float it in water, and it will at once move so as to point north and south. If another needle, magnetized in the same direction, be held near the floating needle, it will at once be noticed that any two like poles will repel each other, attraction only taking place between north and south, or unlike poles; hence, the important and well-known rule, "Like poles repel, and unlike poles attract each other." The earth is a huge magnet whose poles nearly coincide with the

true geographical north and south poles. Magnetism is shown in a natural state in a well-known ore of iron, magnetic or magnetic oxide of iron, discovered centuries ago in Magnesia, a city in Asia Minor, hence the name "magnet." The magnetic properties of this iron ore have no commercial value, as artificial magnets of steel are easily made of any desired strength.

The permanent magnet in its most familiar form is shown in Fig. 14. This is made of a steel bar or

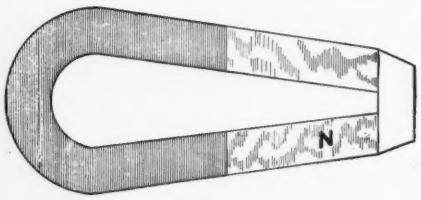


FIGURE 14.

strip bent into a horseshoe form, then hardened, magnetized, and provided with a piece of soft iron or keeper for connecting the ends or poles when not in use. This helps to prevent loss of magnetism. A magnet with only one pole cannot be made, and a single magnetic pole does not exist in nature. If a long magnet be broken into any number of small lengths, each piece will show north and south poles, and exhibit all the properties of a perfect magnet. Iron is not the only magnetic metal, though it is by far the most powerful. The following metals are also magnetic: nickel, cobalt, manganese, cerium, and chromium. Oxygen gas is also magnetic. All other known substances are so little influenced by magnetism that they are called non-magnetic.

An interesting experiment showing the earth's magnetism may be made as follows: Take a rod of steel or a piece of gas pipe, say two feet long; hold it in one hand, pointing it due east and west. Strike the rod a sharp blow on one end with a hammer; test it for magnetism by touching it to iron filings or small tacks. They will not be attracted. Now repeat the operation, but hold the rod due north and south with the north end pointing slightly toward the ground. After striking the rod in this position you will find it has become magnetized quite strongly, and will attract the small bits of iron, while the usual attraction or repulsion of poles will be found on testing it with a compass, and a knife blade may be magnetized by striking it with one end of the bar.

Referring again to our electromagnet, the result of the current flowing through the coils, and its effect on the iron core, is shown by the powerful magnetic display. As there can be no action without reaction, let us see what effect the iron core and magnetizing coils have on the battery and circuit as a whole.

First, disconnect the electromagnet, and touch the battery wires together for an instant. A slight spark will be noticed when the circuit is broken, and if the wire is bare and held by the fingers, a very slight shock may be felt if the skin is not too dry or oily. Now connect the electromagnet in circuit, and the following changes will be noted: The spark on breaking contact will be much brighter and larger, and a much stronger shock may be felt. If the iron core be removed from the coils, the spark will not be so large or the shock so strong, though both effects will be more intense than with the battery wire or leads only in circuit and coils disconnected. As there has been no change in the strength of the battery during these changes, it is evident that the coils and core are responsible for the effects observed, and this brings us to the interesting and important study of electromagnet induction.

A MEDICAL COIL.

A SHOCKING or medical coil is one of the most interesting pieces of electrical apparatus that can be made by the amateur. The one here described simply requires careful work and attention to the details of construction to operate well. Besides affording considerable entertainment to the owner and friends, it can be utilized to good advantage for medical treatment, when prescribed by a physician.

The base is of maple, walnut, or other suitable wood, 7″ by 5″ and $\frac{7}{8}$″ thick. The upper edge may be slightly beveled to improve the appearance. The wooden ends of the coil are 2″ square and $\frac{3}{8}$″ thick. Holes are bored in the centers for the core and regulating tube as hereafter directed, and other small holes H, D, and F for wires, as shown in Fig. 1. These holes should be bored before putting the parts together.

The core C is made of enough lengths of No. 22

gauge, soft, annealed iron wire $3\frac{5}{8}''$ long to give a diameter of $\frac{1}{4}''$. Particular care must be taken with the wire to make sure that it is all well annealed. If any doubt exists about this point, the wire when cut should be tied into a bundle with some surplus wire and heated to a bright red, and allowed to cool very slowly in hot ashes. The rough surface that results will improve the working of the core. To make the core, gather the wires into a bundle as round and compact as possible, and wind with strong twine, leaving $\frac{3}{4}''$ exposed at each end.

metal. A part of the end of an old clothes-brush will answer nicely. It should go inside the tube for about $\frac{3}{8}''$ and be fastened in place by punching two dents into the tube, one on either side, or glued. The regulator is fitted to a hole bored in E′, with enough play to allow it to be readily drawn in and out, but without being loose enough to drop onto the core. A fret-saw and file will be found convenient in making these holes if the worker is not equipped with the necessary bits.

The insulating tube I, 4″ long, is then made.

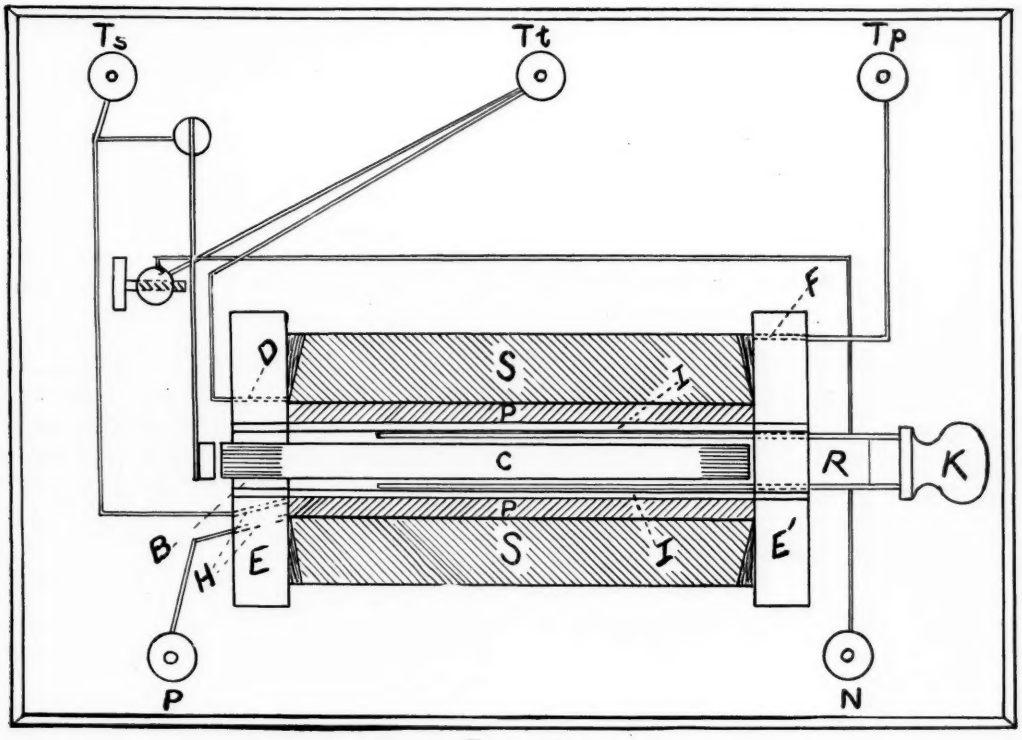


FIGURE 1.

Solder the ends firmly together for $\frac{3}{8}''$, and then file smooth on the ends and around the outside of the soldering. One end is then firmly fitted to a piece of thick brass tubing B, which should, in turn, tightly fit the insulating tube I.

The regulator R consists of a piece of brass tubing $\frac{3}{8}''$ outside diameter, and as thin as can conveniently be obtained. It should slip over the core without touching. A handle K is fitted to one end; this may be made out of anything except

This can be nicely done on the regulator R by first coating it with a layer of soap to facilitate the removal of the tube when completed. Several layers of smooth writing-paper are wrapped around the regulator tube, until the outside diameter almost equals that of the brass cap B on the end of the core. Over the writing-paper wrap five or six layers of smooth manila wrapping-paper, giving each layer, except the last, a coating of thin glue. This is then allowed to thoroughly dry,

then removed from the regulator, and the writing-paper lining taken out. It should then loosely fit the regulator, so that the latter can be easily removed. When the insulating tube is quite dry it will form a firm tube on which to wind the wire. Holes are now cut in the end pieces E and E′ of a size to allow this tube to be inserted with a tight fit, and well glued to prevent it from working loose. The tube is then thickly coated with melted paraffin, laid on with a brush, the joints at the ends being given an extra quantity to insure complete insulation from the core.

During the intervals while the glue is drying, a winding frame, Fig. 2, can be made. The base A is a piece of wood 15″ x 10″ and $\frac{7}{8}$″ thick. The posts B and B′ are 2″ wide, $\frac{7}{8}$″ thick, and $9\frac{7}{8}$″ long, allowing $\frac{7}{8}$″ for tenons to fit mortises in base A. The mortises for the posts are $1\frac{1}{2}$″ x $\frac{7}{8}$″ and are placed in the center of the base, 1″ from each end. One inch from the top of each post a $\frac{1}{4}$″ hole is bored; in post B′, clear through the post; in the other, leaving $\frac{1}{4}$″ of wood to prevent the winding rod from slipping through. In the post B′ saw

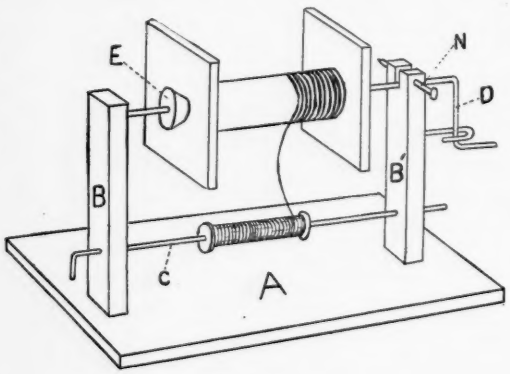


FIGURE 2.

down from the top to each side of the hole, making a slot which allows the winding rod to be put in or taken out without having to adjust the work. About $2\frac{7}{8}$″ from the bottom end of each post bore $\frac{1}{4}$″ holes for the rod C, upon which the wire feed spool is run. The rod D is 21″ long, with two 3″ turns on one end to form a crank. A small hole is bored in the upper part of the post H to receive a wire nail N, which holds down the winding rod. Two large thread spools are beveled off to form supports for the coil-frame, as shown at E. An extra spool running loose is put on the rod between the coil-frame and the post B′ to prevent the rod from being displaced while winding. A hole is bored in the post B′ in which may be inserted a short piece of iron rod, U-shaped on the end, to prevent the rod from turning when so desired.

Previous to commencing to wind the coil, look the frame over carefully to see that the paraffin coating is without air holes and cracks. If any are found, they should be filled up. It is then mounted on the rod D. First, put on the loose spool and then one of the tapered spools E, then the coil-frame, then the other tapered spool, the tapers being firmly centered in the holes in the end of the coil, and kept in position by paper bushing, wrapped over the rod D at the proper places. The rod and coil-frame are placed in the winder and the primary coil wound. This consists of four layers of No. 22 cotton-covered magnet wire. The end is first passed through the hole H, which ends nearest the tube, allowing about 8″ extra length for connections. It is held by a temporary wedge in the outside end of the hole. By turning the crank with one hand and holding the wire between the fingers of the other, the wire can be evenly and solidly wound. After each layer is in position, a coating of thin shellac, cut in alcohol, is put on. As it dries very quickly, but little time will be required, and in addition by being well insulated, the wire will wind more evenly. The end of the fourth layer will be at the same end of the coil as the first layer, and should be carried through the other hole H, with about 8″ spare wire for connections. These spare ends may, during the winding of the secondary coil, be twisted around a pencil into a small spiral.

Before winding the secondary coil the primary coil should be covered with two layers of thick note-paper, which previously has been well soaked in paraffin. Any unevenness should be smoothed over with additional paraffin, so that the windings of the secondary coil may be regular and level. The joints at the ends should be completely filled with paraffin to prevent short circuits between primary and secondary coils.

The secondary coil consists of 15 layers of No. 36 cotton-covered magnet wire. The end is carried through the hole D, leaving about 8″ for connections. It is temporarily fastened with a

plug. Owing to the fineness of the wire and the liability of breaking, the ends are often of larger wire, with soldered connection, well covered with cotton thread and waxed. The secondary is wound in the same direction as the primary coil, each layer being coated with shellac, as previously described. The wire should be carefully watched during the winding to locate breaks or splices. If either are found, twisted joints should be made and well covered with fine cotton thread and wax. Each layer should end one turn further from the end than the one under it, the remaining space being filled with paraffin. If the last layer is likely to be rather uneven, a layer of note-paper over the next to the last layer, coated with shellac, will allow the last layer to be wound evenly. This should be shellacked, the end, with spare wire for connections, being carried through the hole F. A covering of black velvet or bookbinders' leather will give the coil a more finished appearance, as well as protect the coil from being damaged by use. When the winding is completed, the core is then placed in position and strongly fastened with glue. It should fit very firmly and be centered so that the regulator may be pushed in and out without touching it.

Five binding posts are fitted to the base, as shown in Fig. 1. Holes should then be bored in the base to receive the wires from the primary and secondary coils. Six brass-headed upholstering nails are driven into the under side of the base to support it and prevent the wiring underneath from being broken.

The contact-breaker consists of a piece of thin spring steel $2\frac{1}{2}''$ long and $\frac{3}{16}''$ or $\frac{1}{4}''$ wide, on one end of which is soldered a piece of soft iron $\frac{3}{8}''$ square and $\frac{1}{8}''$ thick, which forms the armature. The other end is fastened in a slot in the top of a brass or iron post $1\frac{1}{4}''$ high, so placed as to bring the armature opposite the end of the core. The post can easily be made of a brass bolt, the slot being cut with a key-maker's file or hacksaw. The end of the spring is then placed in the slot and the two sides hammered gently until firmly closed onto the spring. With one nut above the base and one on the under side, the post can then be firmly fastened in any desired position. Another post with a regulating contact-screw in the top is placed $1''$ nearer the coil, but outside the spring. A screw-hook may be substituted for the contact-screw and post to save work. It should be about $2\frac{1}{2}''$ long, and screwed through the base far enough to allow the wire connections to be made.

When all the parts are completed, they should be fastened to the base, the armature on the contact-breaker not quite touching the core, and having an outward play of about $\frac{1}{8}''$. The wires from the primary and secondary coils are carried under the base to make the connections shown in Fig. 1, as follows: The outside end of the primary coil is carried to the binding-post P; the inside end of the primary coil to the post carrying the spring and armature. The post with the contact-screw is connected to the binding-post N, and also connected to the binding-post Tt. A splice is made on the wire from the inside of the primary coil and run to the binding-post Ts.

The inside end of the secondary coil is connected to the post Tt, and the outside end to the post Tp. The wire for these connections should be heavier than the coil wire, say No. 18 annunciator wire. The wire plan in Fig. 1 is simply to show the proper connections. The wires are carried as direct as possible. The battery is connected to the posts P and N with No. 18 annunciator wire. Two Leclanche cells connected in series will probably furnish all the current desired. Handles for shocking are made from pieces of thick brass tubing 4" long and $\frac{3}{4}''$ diameter. Wooden handles are fitted to one end. Flexible wire cord, such as is used on incandescent drop-lamps, makes good connecting wire from coil to handles. It should be soldered to the tubing, and at the outer end a coating of solder will prevent breakage from use in changing terminals. Connecting the wires from the handles to the posts Tt and Tp, the shock will be that given by the primary coil only; posts Tt and Ts give secondary coil only; while posts Ts and Tp will give both primary and secondary. The first connection will be found the weakest, the second much stronger, and the last quite powerful. With the regulator out, each connection will be at its full strength, but by sliding in the regulator, they are reduced. In first testing the coil, do not take the full strength, but work up to what you can stand with comfort. Electricity, like anything else, is to be taken in moderation. Some adjusting of armature spring and contact-screw will probably be necessary before the current-breaker will work correctly.

A HOME-MADE COLONIAL CLOCK.

HENRY M. CHADWICK.

FOR convenience I shall divide the woodwork into three sections: the base, or the square box portion at the bottom; the shaft, or long narrow part; and the head, or top.

The base is made of four pieces of mahogany. The front is 1′ 6½″ high and 1′ 6½″ wide. The two sides are 11 1/16″ wide and 1′ 6½″ high. The back is 1′ 6½″ high and 1′ 4⅜″ wide. All four pieces are from stock ⅞″ thick and planed on both sides.

The drawing shows a rabbeted joint at the two front corners. To make this by hand, proceed as follows: Lay the front board on the bench and mark a line exactly where you want the rabbet to be. It is best to make the lines with a knife point or with a hard pencil sharpened to a chisel edge. Next tack a piece of ⅞″ board, whose edges are straight and whose sides are square, close to the line. Place your saw against the straight edge and tack another straight piece close to the other side of the saw. Saw exactly half-way through the board and cut out the wood with a sharp chisel, smoothing up with a small iron plane, or the side cut may be made with the saw by placing the board in a vise and tacking on strips the same as for the top cut. Lay off the rabbet on the other side exactly parallel to the first one, and repeat the operation. Square up the board with the edges of the rabbet.

To the inner side of the front and ends screw six pieces of ⅞″ pine board about 3″ wide, planed on both sides. (See Section C, D.) These pieces serve as cleats to keep the base-boards straight, and also as blocks to which is screwed the shaft after it is slid into the base. Glue all joints before nailing, and fasten with wire nails, setting the heads about ⅛″ into the wood. If you have no nail set, use a large wire nail with the point filed off square.

The stock for the shaft is ½″ thick and planed both sides.

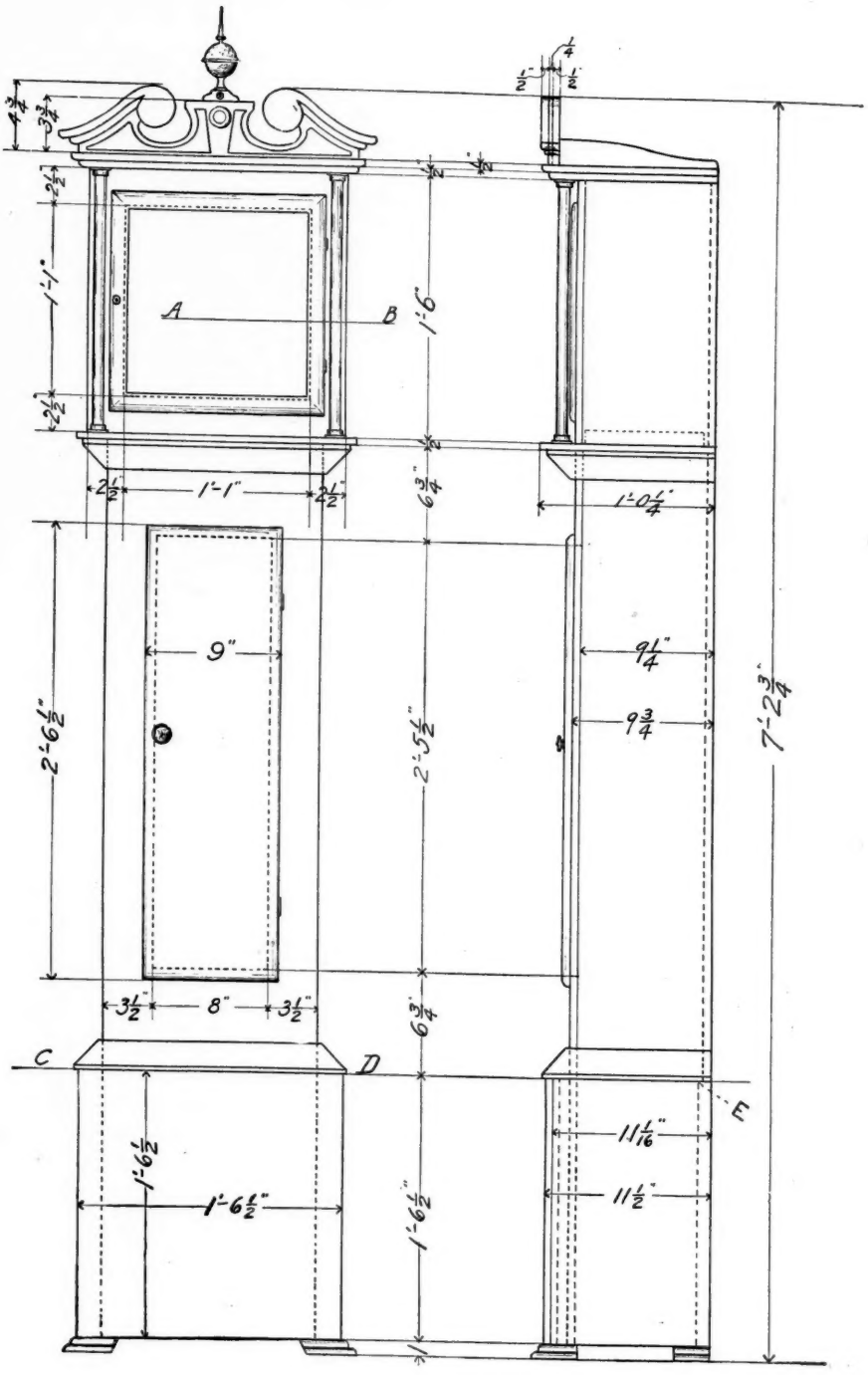
The front board extends from the bottom of the base to the under side of the horizontal board of the head on which the two pillars stand. This makes it 5′ 1½″ long. The two sides are the same length; they are 9¼″ wide above the base, and are notched at E on the rear side to about 8¼″ to admit them into the base. The position and size of the doorway is easily ascertained from the drawing. The back board is even with the tops of the front and sides of the head, and extends down to the top of the back board of the base, and is flush with the outside of the latter. It is placed between the two sides; this makes it 1′ 2″ wide and 3′ 7″ long.

Bore two 9/16″ holes each in the front and sides opposite each of the six cleats in the base. Glue and brad the front and sides together, slip them into the bases and screw to the cleats with 1″ round head screws. Each screw should have a round iron washer under its head.

It is well, though perhaps not necessary, to put two or three white pine cleats on the sides, and two on the front, one above and one below the door. This will prevent the boards from warping. Do not, however, glue these cleats on, simply use screws. If they are glued on and the boards swell with dampness, you may have a cracked clock in your hall.

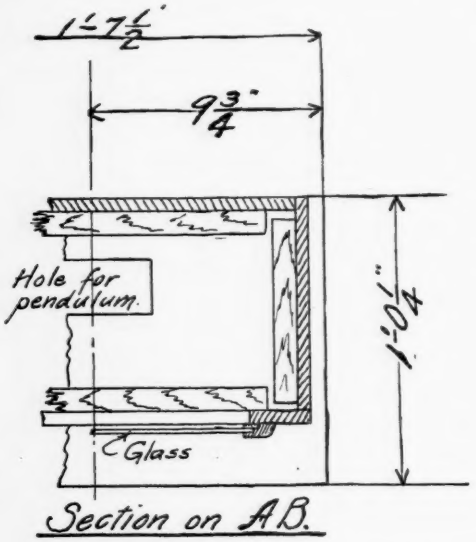
The door is a single piece, with rounded edges, 9″ wide and 2′ 6½″ high, with two cleats screwed to the inside. It is fitted with brass hinges, and a brass knob that has a tongue on the inside to engage in a slot in the side of the doorway. Do not fasten the door on until after the clock is finished, as it is liable to become marred during the work.

The two moldings are alike, except that one is turned up and the other down. They must be cut carefully in a miter box with a sharp saw. If


A
B
C
D
E
1'-1"
1'-6"
1'-0¼"
9"
8"
1'-6½"
11 1/16"
11½"
7'-2¾"
2'-6½"
2'-5½"
1'-7½"

you do not get a good close joint in the corners, mix some sawdust with a little thin glue and fill the cracks with it. Let it dry well, then sandpaper the joints.

The head is all ½″ mahogany, planed on both sides. The front is a square frame 1′ 6″ outside and 1′ 1″ inside. It is made from four strips 1′ 6″ long and 2½″ wide. The joints are halved together, the upright pieces being on the outside and glued



and also fastened with two screws to each joint. This can be made nicely with a miter saw if the cuts are first carefully marked.

The two sides are 9¼″ wide and 1′ 6″ high; the back is 1′ 5″ wide and 1′ 6″ high; the top is 1′ 7½″ x 1′ 0¼″ with rounded edges. The second thickness shown on the top is obtained by tacking three mitered strips to the top board, rounding the edges with a plane, and letting them project about ¼″.

The bottom board is glued and nailed to the top of the shaft; it has square edges and a hole for the pendulum, otherwise it is like the top board.

The ornament on top is made from three thicknesses. The back piece is ½″ thick and follows the outline of the scrolls. It has no openings.

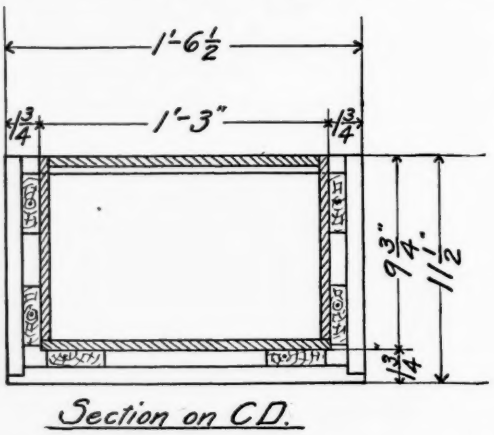
The middle piece is ¼″ thick and has two openings, cut so that when placed against the back it gives the effect of a recess on each side of the center. The front thickness is simply the wing, having the two sweeps carved with a chisel. Of course it is better to do this part of the work with a jig or band-saw, and if you have not access to either, have it got out at the planing mill rather than try to carve it with a chisel.

The Door. The frame is made of mahogany 1″ wide and ½″ thick. With a circular saw cut two rabbets in each of the four pieces, one for the glass and one for the strip to hold it. (See section on A B.) A beveled plate glass adds greatly to the appearance and costs about one dollar. Take the glass frames and strips to a picture framer, and he will miter the corners and put the whole thing together better than you can do it yourself unless you are experienced in that sort of thing.

Mount the door with two small brass hinges and a knob. Drive a brad with the head cut off into the edge of the frame about even with the knob to catch in a hole punched in a piece of spring brass that is turned under the door frame and tacked to the front board.

The pillars were made of a piece of mahogany 1″ square and turned in a lathe to ¾″ diameter. The bases and caps for the pillars, also the sphere on top, are of brass purchased of a dealer. Use round head brass escutcheon pine to hold the bases and caps in place.

On the top side of the bottom board of the head screw four pieces about ⅞″ square, to which to



fasten the vertical boards of the head. Put ⅞″ square pieces on the under side of the top, the same as were placed on the bottom. The front frame, the two side boards, and the top are then put together, but the back must be left loose, as the clock movement is to be fastened to it. This

back should be screwed on, but not glued, after the movement is in place.

There is a wide range of choice to be followed in buying a clock movement, but whatever one you get will have to be fitted to the back board by building up with blocks until the spindles project through the dial. Put two stout hooks or knobs on the back board to facilitate its removal for cleaning or repairing the movement. I finished my clock by applying three thin coats of orange shellac. The first two coats were rubbed down separately with fine sandpaper. The third coat was rubbed with powdered pumice stone and raw linseed oil, and lastly with my bare hand. A darker effect could be obtained by staining the wood before any shellac is applied.

The movement in the clock here described is a Seth Thomas, eight day, and makes eighty beats to the minute. Its cost was $10.00. The dial was made to order and painted on zinc, and cost $2.50. The total cost, including movement and dial, in money was about $33.00. It took me the odd hours and minutes of ten months to complete it.

ASTRONOMY FOR FEBRUARY.

At the opening of this month the great planets will have disappeared, and will not again visit our evening skies until May. Venus alone will still be seen in the west, and she disappears early in the month, coming up with the sun on the 14th.

Mercury will reach his greatest distance east from the sun on the 2d, when he may possibly be seen; at sunset he will be nearly west, but when the sky becomes dark enough for him to be distinguished, he will have moved a little northward. Look for him near the horizon, a little north of due west.

At the beginning of the month the moon will have just passed its first quarter; it is new on the 8th, comes to its first quarter on the 15th, and is full on the 22d.

There will be two occultations this month of stars bright enough to make them interesting to our readers. The first is of the third magnitude star Lambda Geminorum, and the time of the star's disappearance is about two in the morning at Washington, on February 19. On the morning of the 26th the first magnitude star Spica (Alpha) of the constellation of the Virgin is occulted, passing behind the moon at about 4 A. M. Both these disappearances will be at the bright edge of the advancing moon. Perhaps the best way to observe these is to look for the star quite near the front edge of the moon, about half an hour before the predicted time, and keep an eye on it every few minutes until it comes quite close into the edge, and then keep it constantly in view until it disappears. A field-glass should be sufficient to show both of these occultations well.

The first of this month the summer constellations will all be gone.

On the other hand, the Great Bear will have swung eastward and higher, so that in the early evening it will be prominent in the northeast. The Lion will be just rising at 8 o'clock; its first-magnitude star Regulus, being at that time well above the eastern horizon. This star forms the jeweled end of the handle of the great "Sickle," which is the distinguishing group of this constellation, and which will appear in the east with its edge and point forward, about the time indicated. Above it, and between it and the twins, is Cancer, the Crab, the northernmost of the constellations of the Zodiac. It is not conspicuous, containing no bright stars; only the cluster Præsepe (the Beehive) can be easily seen, and is the landmark for this asterism. It is a beautiful object for a field-glass or small telescope.

VEGA.

WHILE the average man knows that the coaster brake saves a deal of pedaling in a day's ride or a week's ride, authenticated records of such savings are rare. The most extended record of the sort of which there is knowledge has but just seen the light — the record of Teddy Edwards on a Barwest coaster brake from New York to Buffalo and return, a matter of 996.6 miles. Of this distance Edwards coasted 210.4 miles, or about 22 per cent, say one mile in every four and one-half, or twenty-two miles in every one hundred. It would be valuable if more records of the sort were available; the record of a season's saving, for instance, would be particularly interesting.

MERCHANT (to new boy): Has the bookkeeper told you what to do in the afternoon?

YOUTH: Yes, sir; I am to wake him when I see you coming. — *Exchange.*

GAS ENGINES.

HENRY C. MILLER.

THE increasing use of gas, gasoline, and oil engines for small powers, and the probability of a much greater development in the near future, make this subject worthy of considerable attention. The simplicity of construction, the low cost and ease of operation, and wide range of adaptability are the important factors contributing to this popularity. The many faults of the first engines were so objectionable that extended use was out of question. Continued experiment, however, gradually removed the objectionable features, until to-day such engines attain a high degree of efficiency. As an economical source of power for small manufacturing and lighting plants, nothing except water power can approach them. They are practically automatic; therefore the expense of constant attendance, as with a steam plant, is not necessary to their successful operation. Any intelligent person who will give proper attention to the instructions will have little or no difficulty in obtaining satisfactory results. The many avenues still undeveloped are plainly evident when we consider the hundreds of small hotels at seaside and country resorts that still use kerosene lamps for light, and do laundry work and freeze ice-cream by hand power. A still larger number of manufacturing plants using steam power, for which the cost of the engineer-fireman in charge is greater than for the fuel used, would find a change to gas-engine power of decided benefit. Many small country villages could establish a cooperative lighting plant and enjoy the benefits now reserved to larger places.

Accompanying this increase in plants will come a demand for competent men to take charge of them. The young men who are wise and energetic enough to study electrical and engine work now will have no difficulty in securing satisfactory positions when they become competent to fill them. These preliminary observations are inserted for the purpose of enabling the reader to appreciate the importance of the subject and influencing him to more extended study of it, should it prove to be of interest.

We will now consider how such engines are constructed and operated, gas engines being understood, in this article, to include those using both gas, gasoline, and kerosene. A gas engine utilizes the expansive force of the nitrogen in air resulting from the heat developed by combustion. A certain volume of hydrocarbon gas, together with a larger volume of air, are inclosed in a cylinder and exploded. The heat due to combustion expands the nitrogen of the air, and the watery vapor resulting from the union of the oxygen of the air and hydrogen in the gas, as well as the monoxide and dioxide, products of combustion formed by the union of the carbon in the gas and the oxygen in the air. This expansive force is exerted upon the piston and conveyed by the piston-rod to the crank and crank-shaft which revolves and becomes available for transmitting power by belt or other device. As compared with the steam-engine, it utilizes a larger proportion of the heat developed. The steam-engine converts into useful energy from 12 to 18 per cent. of the potential heat units of the coal. A gas engine secures from 18 to 25 per cent. or more.

The gas used in these engines may be the regular illuminating or fuel gas, or may be the vapor of gasoline, naphtha, kerosene, or petroleum. In the latter case the fluid is vaporized, previous to being admitted to the engine, in what is termed a carbureter. This is a device for applying sufficient heat to the fluid to convert it into vapor, and is automatically regulated to supply the vapor only as needed.

In some types of engines the gas or vapor is admitted to the cylinder, and there mixed with a suitable volume of air; in other types this union is effected before being admitted to the cylinder. The method of admitting the charge also varies. In one type, termed the two-cycle engine, the gas and air mixtures are drawn into the cylinder during a part of the outward stroke, exploded and expanded during the rest of the stroke, and the products of combustion exhausted during the return stroke. This type of engine develops about 20 per cent. of the heat value of the gas used. Some engines of this type also compress the gas mixture on the last part of the inward stroke. The four-cycle engine admits the gas mixture on the first outward stroke of the piston, compresses it on the inward stroke, explodes it on the second outward stroke, and exhausts on the second inward stroke, an expansive impulse being given only with every other stroke. In this type of engine the compression of the mixture gives the explosion far greater

expansive force than in the non-compression type, thus overcoming the loss due to the less number of explosions.

In all types of engines the explosions and consequent number of expansive impulses are as rapid as is mechanically possible. This means high piston speed, so that the expansive effort shall be exerted on the piston as often as possible. The exhaust should be quick, that the hot gases may not overheat the walls of the cylinder. The rapidly repeated explosions generate a high degree of heat, which is removed by radiation. In small engines this is generally effected by the air, the outside of the cylinder being covered with corrugations similar to a steam radiator, only deeper. With large engines and some small ones, the cylinder is surrounded with a water-jacket, which prevents the excessive heating of the cylinder that otherwise would follow. This is connected to a supply tank, the warm water being of less specific gravity, rising and being replaced by cooler water. A constant circulation is thus maintained, which serves to keep the cylinder at the right temperature. One of the important features of gas-engine design is the regulation of the water circulation so that the cylinder shall be kept at just the right degree of heat to most economically utilize the power developed.

There are several types of devices for firing the charges in gas engines. The direct flame ignition is through a hole in the cylinder wall, which is uncovered by the piston at the proper moment, and the flame admitted to contact with the gas mixture. It is protected so that the explosion will not extinguish the flame.

The tube igniter consists of a metallic tube, preferably platinum, externally maintained at a high heat by a burner of the Bunsen type, into which the gas mixture from the cylinder is admitted and fired, thus firing the mixture in the cylinder. Careful designing and adjustment of this type is necessary to successful working.

Electric ignition is secured by a spark between two platinum electrodes inside the cylinder. The current may be generated from either a primary or storage battery and induction coil, or by a permanent magnet generator driven from the engine shaft by a belt. This latter dispenses with the battery and its care, and also the induction coil, and is increasing in popularity. Some engines are equipped with both tube and electric ignition.

The lubrication of cylinders is a matter of much importance with engines of large size. The intense heat of the exploded gases has a tendency to thicken some kinds of oil and make a gummy deposit on the surface of the cylinder, which would seriously affect the smooth running of an engine. Mineral oils of a high grade should be used, and the oil-feed regulated to the minimum amount that will prevent wear.

The efficient governors now in use on gas engines afford close regulation of speed and allow freedom from constant personal attention. The type most generally used regulates by increasing or decreasing the supply of gas or gas vapor.

Regularity of piston movement is secured by heavy fly-wheels on the crank-shaft which, by the acquired momentum, overcome the violent increase in speed that would otherwise follow the explosions. A heavy bed is also necessary to secure steadiness. A firm foundation is desirable, as with all engines, to prevent vibration.

In the management of these engines cleanliness is the important desideratum. The cylinder, feed, and exhaust pipes should be regularly examined to see that they are in proper condition. The frequency with which this is done depends largely on the service being performed. In dusty workrooms, a separate enclosure would be advisable, otherwise the dust-laden air will cause a deposit of sediment that may be troublesome. When examining an engine see that it is freed from the gas mixture by giving it two or three turns. Do not open valves for examination with a lamp or gas flame near at hand until satisfied that no gas leakage is liable. An electric light may be used with more freedom. The special details of particular makes of engine are fully covered by instructions accompanying them.

The power of a gas engine should approximate that used, as engines largely in excess of requirements are not as economical as when correct power is used. The excessive cost is not prohibitive, but should be avoided if possible. The probability that Texas crude petroleum may soon be available at low cost may serve as an incentive to develop oil using engines. With cheap petroleum, an efficient oil engine would find many uses.

AMATEUR WORK

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OUR readers are invited to submit topics which they would like to have presented in these columns. Those interested in AMATEUR WORK desire to make it the most helpful and interesting magazine that can be published for young men and boys. If readers will write about what interests them, the information thus obtained will be of much value to the editors and guide them in their work of preparing suitable subjects.

"HAVING seen a copy of AMATEUR WORK, I am much pleased with it," and similar statements, appear so frequently in our correspondence that we are led to ask our readers to mention the magazine to their friends. Being a new magazine, many who are interested in the subjects it presents are not aware of its publication. If brought to their attention, they would become regular readers, thus greatly increasing the circulation, which, in turn, would enable the size and scope of the magazine to be enlarged, something the publishers are very anxious to do. If our readers will speak a favorable word to those of their friends whom they think would be interested in it, this result can soon be accomplished.

As many of the things, the construction of which are described in the magazine, are beyond the attainments of younger readers, arrangements have been made to present articles especially adapted to elemental work. This will enable the beginner, as well as the more experienced amateur, to find in each issue something of interest upon which skill may be developed that will lead to more advanced work.

Two or three weeks ago the electric lights in Buffalo went out with a wink and all the street cars stopped. At the same time Lockport and Tonawanda were similarly afflicted, and considerable excitement reigned until the trouble was removed. It was found that a cat, of the common or back-yard variety, had climbed a pole on the transmission line, driven thereto possibly by a dog, and managed to short-circuit the 11,000-volt transmission line. The cat was killed.

THE wave motion of the sea is utilized to run the electric-lighted buoy at the mouth of the river Elbe in the North Sea. The least motion of the water is sufficient to generate the electric current, which, when not needed, passes to storage batteries. The success in this case and in the generating electricity by means of floats off the shore of Los Angeles, Cal., is encouraging to the belief that the power of the waves will later be made valuable to coast towns.

MECHANICAL DRAWING.

Earnest T. Childs.

IV. Objects in Section.

The work which has been taken up thus far by the student covers simply outline drawing, with very few concealed or dotted lines. To make the representation more complete it is often necessary to show the object in section; that is, it is assumed that the object is cut at a certain point, and the drawing is made showing the exact shape of the object where it is cut off. For instance, if all the dotted lines in the upper left-hand view of the tee on page 41 of the December issue were shown full, this view would then represent a cross section of the tee. The use of sections is often very necessary to avoid the confusion of a great many dotted lines. There are several conventional methods of showing that the object is in section. The most common of these consists of parallel lines drawn usually at an angle of 45 degrees across the cut surface. When cross-sections of two different pieces adjoin each other, it is customary to draw the section-lines of one at right angles to those of the other, thus adding to the clearness of the drawing.

The representation of different materials may be indicated by varying the character of the section-line. There is no standard for the line which shall indicate a certain material. Every drawing room has its own standard, which may or may not agree with others, and if there is a possible doubt as to the material required, it should be indicated by a note on the drawing. Fig. 9 shows a very convenient set of conventional sections which are generally used, though they are not positively standard. A represents cast iron; B, wrought iron; C, brass or bronze; D, babbitt metal, which is commonly used to line journal boxes; E shows steel; F, brickwork; G, wood, the upper part indicating that the section is across the grain, the lower showing that the section is with the grain of the wood; H shows stone. There are other graphic symbols showing concrete, earth, and other materials which it is not necessary to describe, the variety here given being sufficient for the needs of the ordinary draftsman.

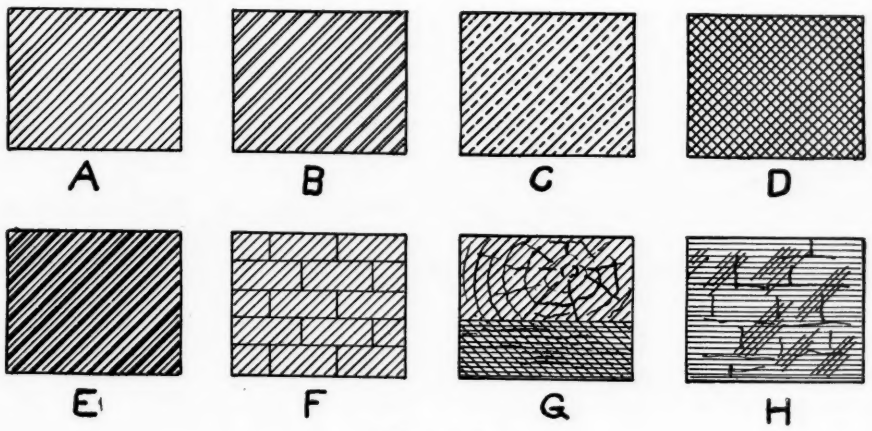


Figure 9.

The spacing of section-lines must be determined by the size of the section, but care must be taken not to space them too close, as this adds to the labor, and often draws undue attention to one particular part of the drawing.

The regulation of the space between section-lines is often left entirely to the eye, but if a great deal

of sectioning is to be done, it is more readily and rapidly finished by the use of a section-liner.

There is a great variety of these instruments on the market, all of which are on the same general principle, and cost more than the amateur may care to pay for them. A simple liner may be made by any one by taking four pieces of wood, each about one-eighth of an inch thick and one and one-fourth inches wide, having both its sides parallel. These pieces should be about one and one-half inches longer than the 45 degree triangle, which is to be used for the section work. One side of each piece should be notched for a length varying from $\frac{1}{32}$″ to $\frac{3}{16}$″ longer than the triangle, and for a depth of about one-half inch. This will give four different widths of space, which will be ample for ordinary sectioning. A more convenient arrangement consists of a single strip of wood with an adjustable block on one end, so that by turning a small screw any width of space may be obtained. (See Fig. 10.) In using this arrangement it requires a little practise, but in a short time it will become an easy matter, and the relief to the eyes is very appreciable. The wood strip should be held against the blade of the T square to prevent it from getting out of line. The triangle and wood strip are moved along alternately, the stop limiting the motion and keeping it constant for each line. If it is thought advisable to purchase a section-liner, they may be obtained at any price from $1.00 up to $5.00, or even more. One of the neatest of the liners on the market is on the principle of the

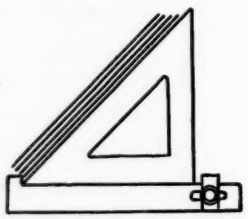


FIGURE 10.

one shown by Fig. 10, except that the movable strip is secured to the inside of the triangle, and the adjustment is obtained by an eccentric-shaped metal piece, which will vary the width of the motion. This is known as Hill's combination section-liner and triangle, and lists for $1.00. Anything more elaborate will be too expensive for the ordinary draftsman.

An extremely important item in the making of

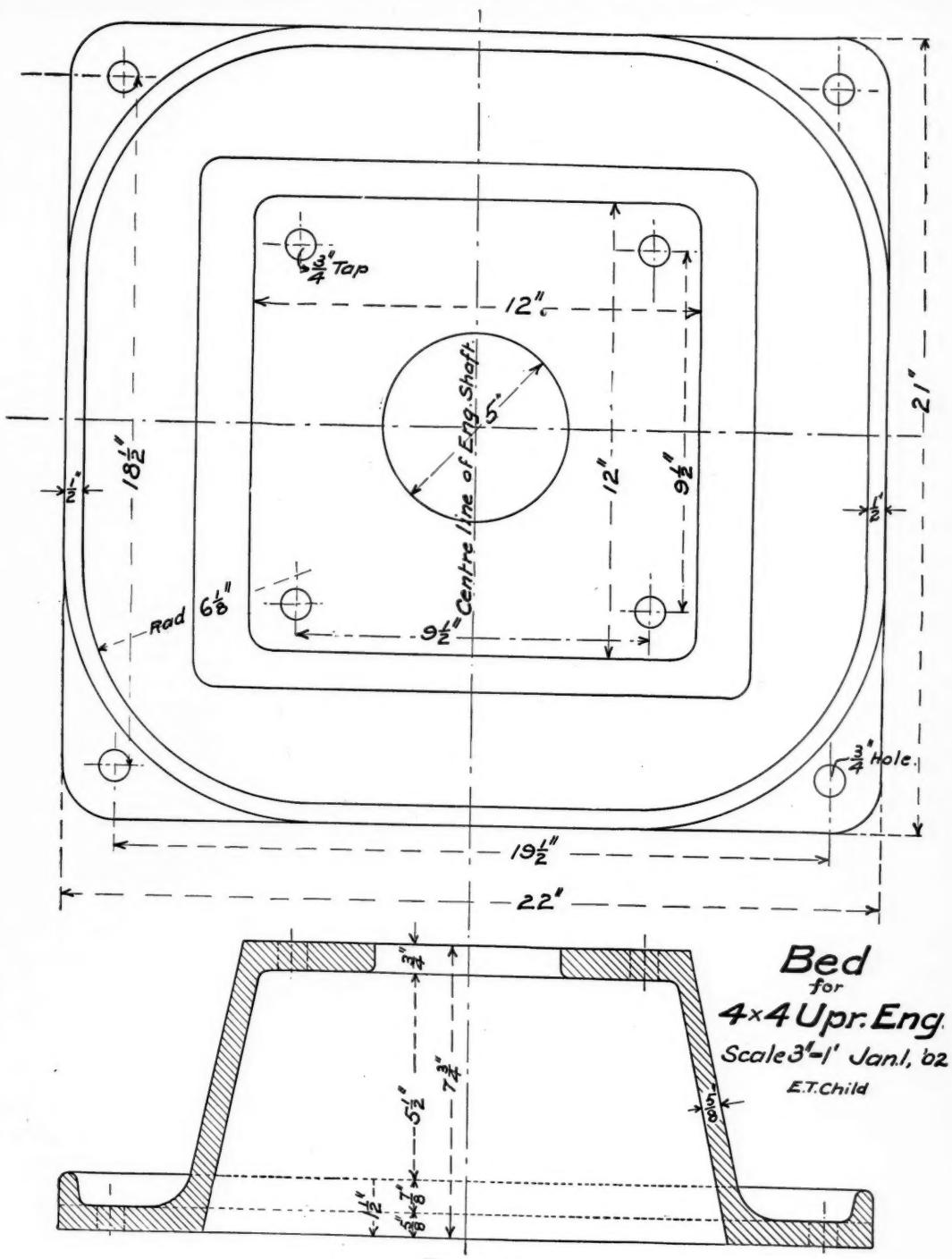

3/4" Tap
12" c
5"
Centre line of Eng. Shaft
12"
9½"
21"
18½"
Rad 6⅛"
9½"
3/4" Hole
19½"
22"
Bed
for
4×4 Upr. Eng.
Scale 3"-1' Jan. 1, 02
E.T. Child
3/4"
5½"
7¾"
1½"
⅜"
⅞"

FIGURE 12.

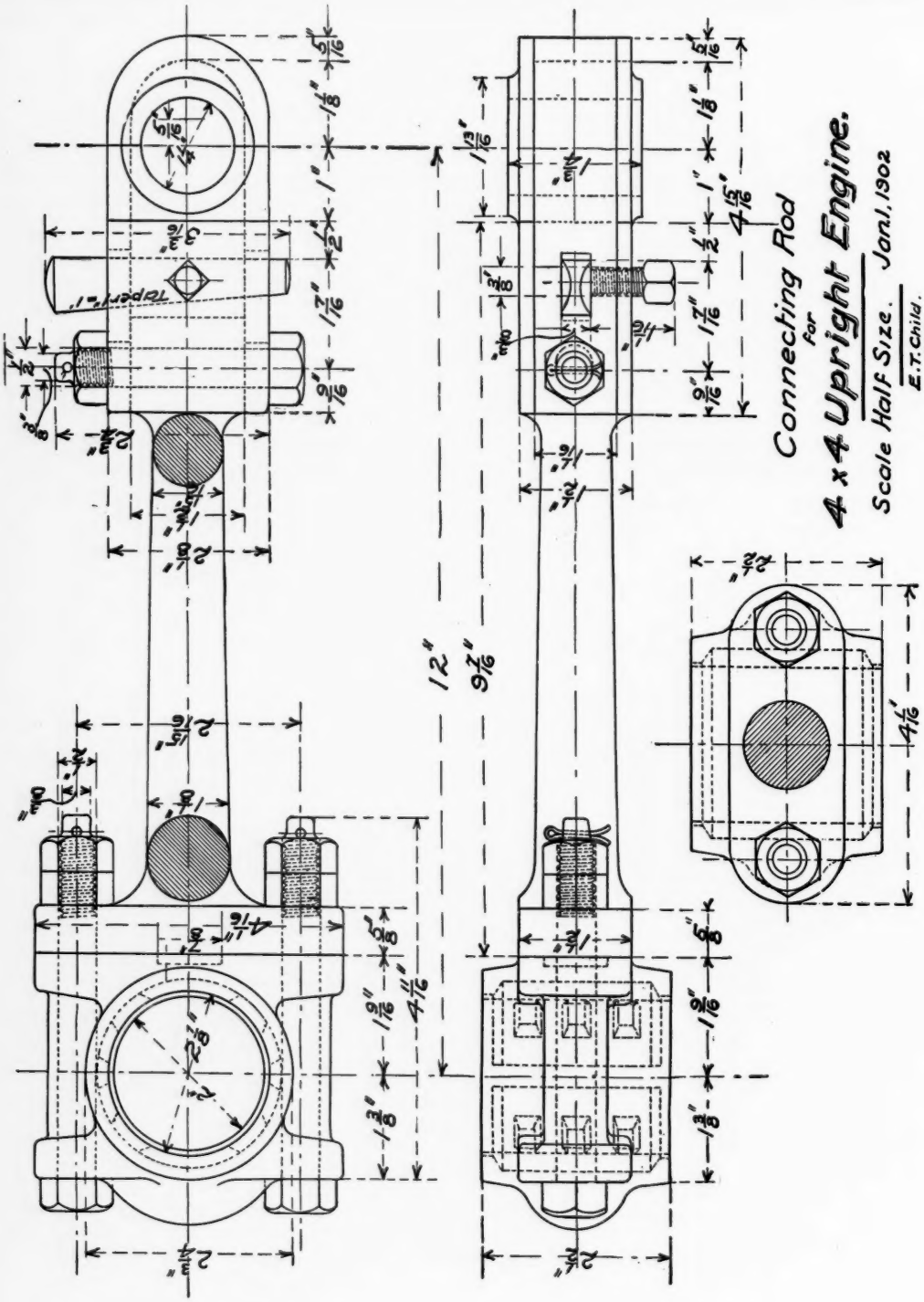

Connecting Rod
for
4 x 4 Upright Engine.
Scale Half Size. Jan.1,1902
E.T.Child.
Taper 1"
12"
9 7/16"

FIGURE 13.

a mechanical drawing is the class of letter to be used. The great majority of draftsmen can make a good line drawing, and can make fairly legible figures; but a great many find difficulty in making the notes and title uniform, and the skilled letterer always commands a good salary. It often happens that perfect lettering is not necessary for the work in hand. This is particularly true in the case of large manufacturing concerns who make drawings principally for shop or field construction. Municipal and private engineers often spend a great deal of time and trouble on their lettering and have specially trained experts who do nothing but this class of work. The ordinary draftsman, however, needs a simple letter which is readily made, and which is clear and legible without taking an unduly long time to learn the use of and to put on the drawing.

As stated in the December issue, the writer's experience goes to show that an Italic Gothic letter, entirely devoid of flourish, is most readily handled by the largest number of draftsmen. With a few day's practise, a draftsman can make a neat looking title, and a new man, absolutely untrained, can be taught the use of this letter within two weeks. In a room of thirty draftsmen, all but two are handling this letter, and there is so slight a variation that it is next to impossible to know by the lettering which man did it. In other words, the individuality of the draftsman is not in evidence with this style of letter. The result is great uniformity in the titles and notations on the drawings and a correspondingly neat appearance of the drawing files. This alphabet, together with the figures appropriate to use with it, is shown by Fig. 11. It will be seen that the capital letters are made by a double stroke and are shaded, and the lower case letters are made by a single stroke of a coarse pen. It will be evident to all that these letters are made free hand. This is purposely done to illustrate to the student the degree of proficiency which is necessary to produce a neat note or title. Whenever any lettering is to be put on the drawing, the lines must be ruled, as shown in Fig. 11, so that the work will be even, as it is next to impossible to keep the work even unless this is done. For notes, etc., the capitals are made with a single stroke, unshaded, and for titles the small letters may be made heavier and the shade lines used. (See detail of Connecting Rod, Fig. 13.) Special attention is called to the lines which form the letters. It will be seen that they are square at both ends and slightly wider than at the center, the bottom being a shade heavier than the top. This gives the lines character and balance, which would be missing if the lines were of the same weight throughout, or were made thicker at the center than at the ends. These letters stand at an angle of 60 degrees, but they may be written in a vertical position if desired. It is found more difficult by the majority of men to handle a vertical line than a sloping one, and the 60 degree angle is to be recommended particularly for this reason.

Fig. 12 shows the bed of the 4 x 4 engine. This illustrates the use of the section showing a symmetrical object. It will be seen that the section is taken on the center line of the base, at right angles to the shaft. The $\frac{1}{2}$ inch head is shown in the plan, and the section shows its height as well as the general outline of the base. The section does not cut through any bolt holes, and they are shown dotted. It does, however, cut through the center of the 5 inch circular hole in the top of the base, and this part, not being cut, is not section lined. It will be seen that very few dimensions are necessary and repetitions are avoided. This drawing is exactly quarter full size and just fills a single standard sheet.

Fig. 13 shows the connecting rod. This is a good study, as it contains several interesting points and will give excellent practise. It should be drawn very carefully on paper, and then traced or inked in. Use tracing cloth if it is available. This gives a good example of the conventional representation of screw threads and bolt heads, and also shows check nuts secured by means of a split pin. This also illustrates one method of showing a section on a side elevation. The cross-hatched circles near the ends of the rod show that the rod is cylindrical at that particular point. Some of the figures are repeated on the various views. This should be avoided as much as possible, but it is better to repeat than it is to omit figures. These two details should be carefully worked up, and when inking do not forget to put in the circles first, and the straight lines afterwards, and use different weight of lines on dotted and full lines. It will also be well to make a practise sheet of cross-hatching after the idea of Fig. 11.

HOW TO BUILD A HOUSEBOAT.

Carl H. Clark.

I. Construction of the Hull.

In this series of articles the writer has aimed to present a set of plans and detailed directions for constructing a small houseboat, — one which will comfortably accommodate six persons and allow good cooking and toilet facilities, and which can be built by an amateur for small cost, or, if this were not desired, could be put together by any ordinary house carpenter in a short time.

The cost of the stock for building the hull and deckhouse, complete, including paint and window-sashes, should not be over $250, and in some localities where lumber is cheap it should be much less.

As may be seen from the sketches, the work is very simple, being all straight work, with no steaming and bending of timbers and plank as in regular boat building. There is no reason why its construction should not be undertaken by any one at all familiar with the use of tools and wood-working. The work must, of course, be carefully done to insure the hull being watertight, but since all the joints are straight, little or no difficulty will be met.

The dimensions chosen — 30′ long, 16′ wide, and 5′ deep — are large enough to give good accommodations, and yet not so large as to make the labor required excessive, or to prevent its being built by two or three persons in a reasonable length of time. The only tools required are the simplest of carpenter's tools.

A general idea of the boat may be obtained from Fig. 1. The accommodations, as shown in Fig. 2, include a large main cabin and living room 6½′ long in the forward end of the house; this room has a seat on each side, which can be made up for a berth. This room is also used for a dining room by the addition of a portable table, which may be taken away at night if desired. Leading from this room is a passage extending through the house, with rooms opening out of it; the first two are sleeping rooms, the larger being 8½′ x 7½′, and containing a full size bed, bureau, washstand, etc. The smaller is 8½′ x 5′, and contains two single berths, one above the other, and bureau, washstand, etc. Next aft are the kitchen and toilet room, the kitchen containing the usual cooking necessities, stove, sink, and closets; the toilet room contains a bowl, tub, and seat.

Forward is a clear space 7′ long covered with an awning, and aft is a similar place, which is to be used as a boat landing and as an approach to the stairs leading to the top of the house, which is fitted with a railing and makes an excellent place for steamer chairs.

There are also hatches in the floor, which allow the hull below to be used for storage of coal and supplies.

Selecting Stock. In ordering the stock it might be advisable, unless one is used to that sort of work, to take the sketches directly to the lumber dealer and let him pick out the necessary stock, as he may be able to select lengths which will cut to better advantage, and so avoid waste. In selecting the stock for the planking of the hull it will be impossible to get it long enough to go the whole length, and it should be selected with the idea of making the joints near the ends and not in the middle. This stock is 2″ thick, and of either white pine or hard pine. Hard pine is the stronger and rather cheaper, although white pine is easier to work. The planks should be at least 6″ wide and a few 8″ wide; it is not necessary to have absolutely clear stock for this, but it should be free from large knots and cracks, which might leak. It should be planed both sides. The framing is made of 2″ x 4″ spruce joists planed on one edge.

For the deck and house ⅞″ stock should be used. It should be tongued and grooved, and preferably of white pine, as it is easier to work, and finishes up better, although spruce or cypress could be used. A small amount of spruce plank about 10″ wide should be gotten for braces and knees. Most of the fastenings in the hull are galvanized nails or spikes about 3½″ long. The window-sashes, doors, and other fittings will be considered later.

Construction of Hull. The general construction is shown in Figs. 3, 4, and 5. Fig. 3 is a cross section showing the framing and planking;

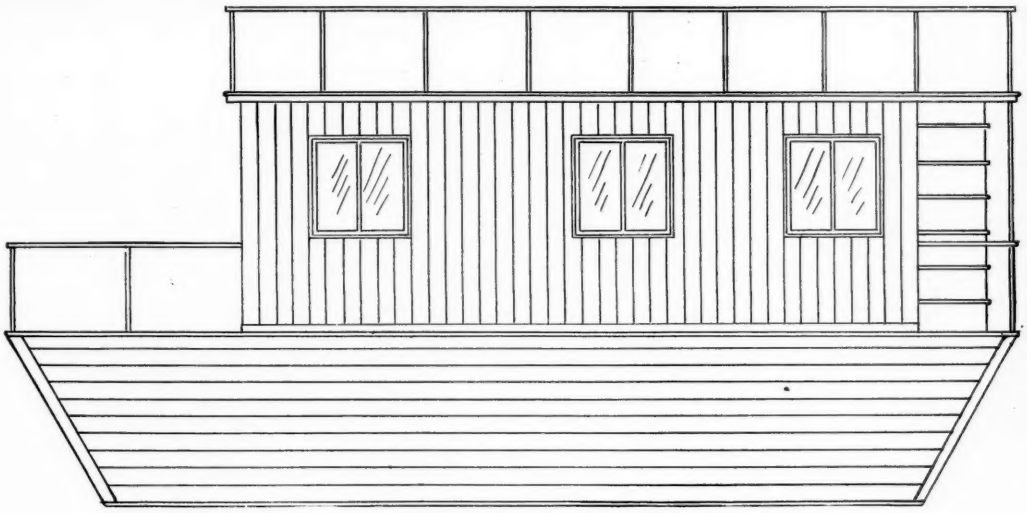


FIGURE 1.

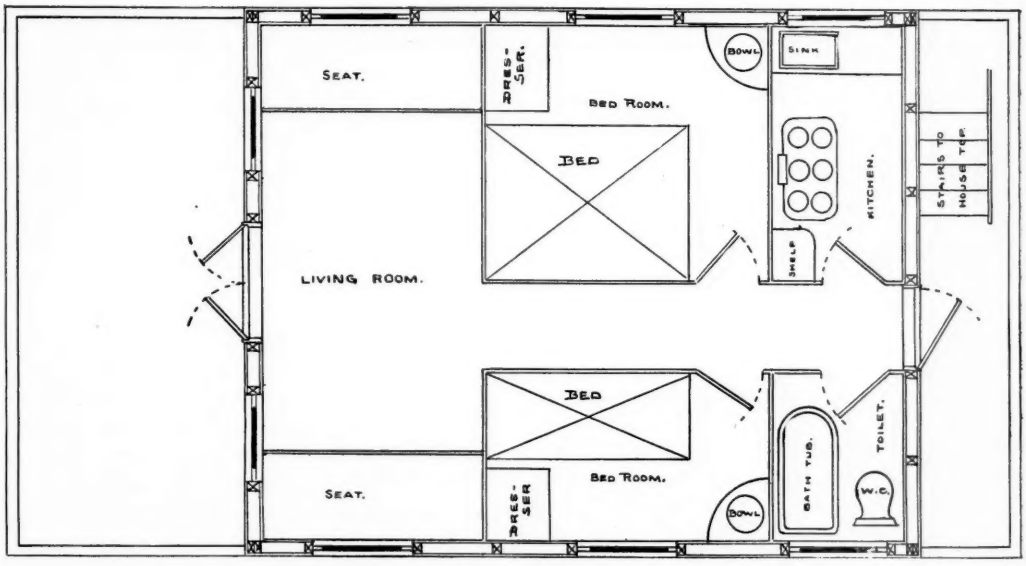


FIGURE 2.

Figs. 4 and 5 show the framing only. The first step is the framing of the bottom. If there is any possible means of turning the bottom over when completed, either by tackle or any other way, it should be built wrong side up if possible, and turned over after being planked; this will simplify the labor, as it will allow the plank to be laid on the top instead of having to work underneath the bottom, which is very tiresome. It must be remembered, however, that it will be quite heavy, and that care must be taken not to strain it and start the joints during the process of turning over.

As will be seen from Fig. 4, the frame is composed of two 2″ x 4″ joists laid on edge along the sides, and cross timbers of the same size laid between them every 2 feet, also on edge, and fastened to them by spikes into their ends through the side timbers. At each end there are two 2″ x 4″ tim-

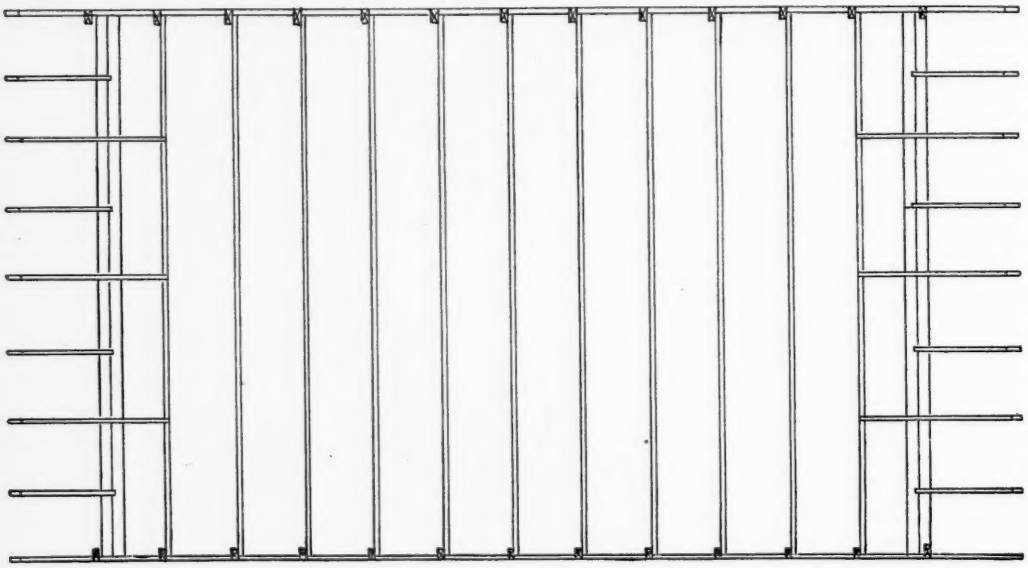


FIGURE 3.

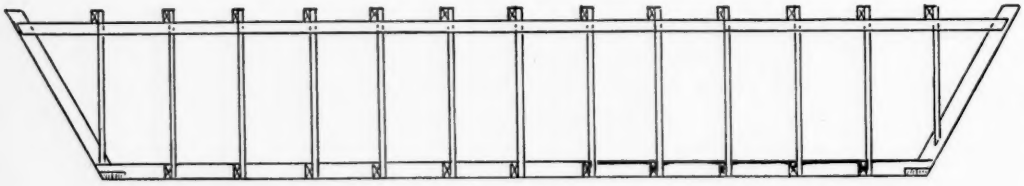


FIGURE 4.

bers laid flat, edge to edge, and fastened the same way.

The two side pieces should be selected, cut 24′ long, and laid out on a flat floor with the planed edge up; the positions of the cross timbers should be marked by laying the two together and marking across both with a square at equal spaces of 2′. The cross timbers, 15 in number, should now be cut exactly 15′ 4″ long, and put between the side timbers and nailed, each one with two 4″ spikes through the side timber into each end. The planed edge should be uppermost, and care must be taken that they are all even with the side timbers and with each other, so that the plank will lie smoothly. A straight edge laid across them will help in adjusting them, any uneven spots being dressed down with a plane. Before putting on any plank be sure that the cross timbers are square with the side timbers. When this is done, it will be well to fasten the frame to the floor, or else cross-brace it to keep it in shape until it is planked, as the shape of the whole boat depends upon the shape of the bottom. When this has been done, the end of the side timbers and the outer edge of the outer cross timber should be beveled off to the slant of the ends. This angle can be obtained by laying out a triangle, using the depth 5′ as a vertical, and squaring out 3′ from the top, since the boat overhangs 3′ at each end. The line connecting these two and completing the triangle will give the angle of the end, which should be kept, as it will be needed later.

The bottom is now ready for planking, the first step of which is to fasten a piece of planking about 8″ wide across each end, letting it lap about 1½″ onto the inside 2 x 4 joist, and extend 2″ on the ends and other side to cover the ends of the plank. This is shown at "a," Fig. 7. The rest of the

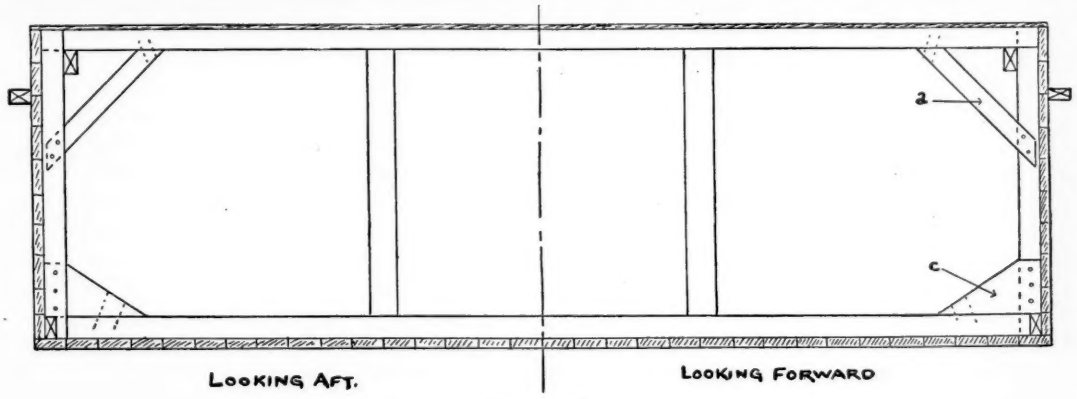


FIGURE 5.

plank are laid the long way, across the timbers; it will be best to begin to plank near the middle and work towards the sides, being sure, however, to have a wide plank at the edge. Before putting on a plank the edges should be slightly beveled towards the outside to allow the insertion of a thread of calking, as shown in rather exaggerated form in Fig. 9. The edges should be about $\frac{1}{8}$″ open when the plank are solid together. The ends of the plank should be squared so as to make a good joint with the end piece, and if the plank are not long enough to go the whole length, the joint should be made to come on a timber, each piece lapping onto the timber half its thickness. The planks are fastened with two $3\frac{1}{2}$″ nails into each timber; these nails should be set down below the

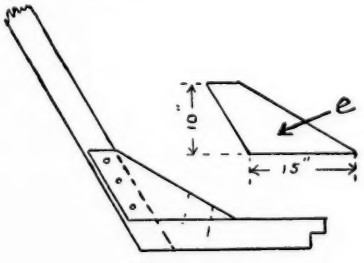


FIGURE 6.

surface about $\frac{1}{2}$″ so that the hole may be filled with cement and protect the head from rust.

It may be best to bore a hole large enough to take the head about $\frac{1}{2}$″ deep; in fact, it may be necessary to bore through with a small bit for the body of the nail if it should show any sign of splitting the plank when driving. All the faces that join should have a coat of rather thick white lead paint before fastening together. The ends of the plank are fastened to the 2 x 4 joist across the end, which forms a bed for them. The butts of adjoining planks must be kept as far apart as possible by making them come at opposite ends, and those in

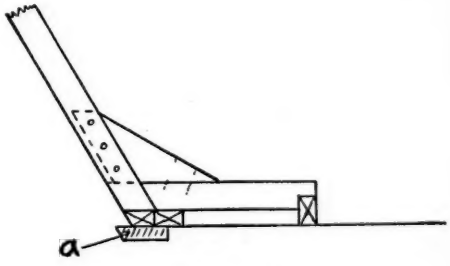


FIGURE 7.

alternate plank on different timbers; this weakens the boat less. It must not be forgotten that the outer plank on each side overlaps the side timber 2″ to take the side planking.

If the bottom has been built wrong side up, it may now be turned over, using care, as before remarked, and set up on blocks or horses about two feet from the floor so that the little work remaining to do underneath may be done easily. The framing of the sides can now be set up. This is of 2″ x 4″ joists; the uprights, 22 in number, should be cut 4′ 9″ long, with a jog 2″ x 4″ to go over the side timber at the bottom. They are put alongside of the bottom timbers, and nailed to them and to the side timber. As will be seen in Figs. 3 and 4 there are four shorter timbers near the corners, which can be put in later. The precaution must

also be taken here to have the surfaces of the side timbers all even so that the plank will lie smoothly. The 2″ x 4″ timber, which is shown near the tops of the side timbers in Figs. 3 and 5, should now be worked in place four inches down from the tops, with the planed side up, remembering that it runs the full length of the hull and is nailed in place. This supports the deck beams and keeps the side timbers in place. If the side timbers are not all even, the uneven places should be planed off until all are in line.

The end timbers, of which there are nine on each end, are cut to the proper bevel of the ends, as already obtained, and long enough to reach to the top of the side timbers. The outer ones bed on the bottom side timbers, and at the top are fastened to the fore and aft timber under the deck. The other end timbers bed on the flat joists. Three timbers on each end are made, as in Fig. 6, with a brace extending out to the first cross timber and notched over it, the corner piece "e" being cut from the rough 2″ plank with the grain the long way. The others are brought down without any brace, and all are nailed to the end cross timbers. A board may be nailed across the ends of the timbers to keep them in place temporarily.

A piece of plank 4″ wide is now taken and spiked on to the side of each corner post, letting it lap over two inches to cover the planking on the

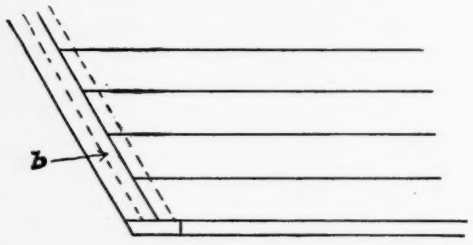


FIGURE 8.

end, and beveling the lower end against the bottom planking already in place, and with which the surface should be just flush. This serves to butt the side planking against and makes a finish, as shown at "b," Fig. 8. The four extra timbers near the corners, already mentioned, should now be put in place.

The planking of the sides and ends had best be begun at the bottom, the lower strake being fastened to the lower side timber, and also a row of nails being driven into the lower plank through the outer bottom plank. The same precautions about butts should be taken as before; the appearance of the end of the side planking is shown in Fig. 8. Above the waterline, if not all over, holes should be bored for the heads of the nails, and the holes afterwards filled with "knugs," as they are termed: plugs of wood, made for this purpose, cut across the grain, which may be driven into the hole and then planed off, making a perfectly smooth surface. They should be dipped into thick lead paint before driving. In driving the nails it will be found necessary to hold a weight, like a sledge-hammer, behind the timber, to take the weight of the blow, and prevent the timber from recoiling. The top strake of the end plank should be beveled off level to take the floor boards.

The next step is the addition of the deck beams. These are also 2″ x 4″ and are spaced the same as the bottom timbers, and directly over them. They should be cut long enough to just fit inside the

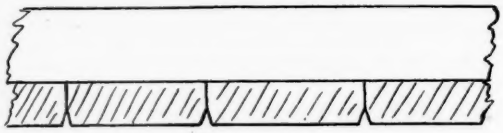


FIGURE 9.

planking, and should be laid, planed side up, on the fore and aft joist, against the uprights, and on the same side as the bottom cross timbers. This will bring them directly over the cross timbers. They should be nailed to the upright, and diagonally nailed to the joist underneath. This should bring their upper edges flush with the ends of the uprights and side plank. Under each beam there should be two upright braces, about equally spaced, to support the deck. These can be made of any spare lumber, and are diagonally nailed to beam and cross timber, Fig. 3.

There should now be cut some pieces from the 10″ plank, like "c," Fig. 3, 15″ on the lower side. These are laid on the bottom cross timber and alongside of the side uprights, and nailed to both. Also some spare pieces of 2″ x 4″ should be cut, like "d," Fig. 3, and nailed underneath the deck-beams and alongside the uprights. All these will greatly stiffen the hull and make it more rigid.

A piece of 2″ x 4″ should be fastened, as in Fig. 3, about a foot down from the deck, on each

side, to serve as fenders. The fastenings should be set well down below the surface, and should go into the side uprights. The ends should be tapered off before being placed.

The laying of the deck is the next thing. Although not absolutely necessary, the deck will be better if laid double; the lower layer of rough stock, as it only forms a bed for the upper layer. Along the sides a rather wide board should be used, as thick as both layers together; this board being fastened to the beams and also to the top strake of plank. The top layer may now be laid. In laying the deck it is well to consider the hatches leading below. These should be about two feet square, and can be placed wherever most convenient, care being taken that they come between beams. There should be one in the living room, one in the kitchen, and one in the passage. By deciding upon these in advance some labor can be saved, as boards can be selected which will extend about to the hatch, and the next board can be laid leaving the opening.

When the hull is completed it must be calked, planed, and painted. In calking, a thread of oakum or cotton is driven into the seams with a calking iron, which is a sort of chisel-shaped iron with a long, flat edge. These may be bought, or made by a blacksmith. If the seam is large, oakum should be used, while cotton is used for small seams. For ordinary use a strand of fibers about the size of a lead pencil is twisted and laid along the seam and driven into place by pounding on the iron with a mallet, lightly at first, and then harder, until it comes to a bearing, and enough should be put in to fill the seam to within about one-half inch from the surface. Care must be used not to force the calking too hard and start the fastenings of the plank. The seam should be well coated with lead paint before calking, using a fine brush. After the calking is completed the surface should be gone over with a smoothing plane, and any roughness or bur removed. If the stock used is not well dried, it may be desirable to delay calking until nearly the last, when the wood will have shrunk all that it will be likely to do. It will probably be advisable to complete the hull before beginning the other work.

All the seams and nail holes should be filled with putty or elastic cement, except above the waterline, where putty must be used, as cement discolors light paint. A coat of linseed oil has a beneficial effect in preserving the wood and preventing shrinking and checking.

The hull should have a priming coat of paint as soon as possible, and in a few days a second coat, leaving the last to be put on just before launching.

The hull is now ready for the deck house, the construction of which will be described in the next issue.

HANDY RECEIPTS.

Furniture Enameling.

Old furniture may be made to present a most attractive appearance by enameling it. The way many do it, by applying one thick coat of enamel paint, is not the proper way, or the way to secure a good effect. The first thing is to thoroughly sand-paper the surface and putty up all holes and deep scratches, so as to get as smooth a surface as possible. Then apply a coat of "flat white," as it is termed. This is simply white lead, ground in oil to remove all lumps, and thinned with turpentine. When dry, the surface should again be sand-papered with fine sand-paper. A second coat may be necessary to secure a very smooth surface, which should also be sand-papered. A coat of enamel paint should now be applied, about the same quantity being taken up on the brush each time and worked in the same direction to avoid brush marks. This will dry smooth and hard, and wear well.

Cleaning Furniture.

Furniture which has become soiled by long use may be cleaned and the appearance greatly improved by the method here described. If a varnished or shellacked surface of natural wood like an office desk or chairs, first clean with the following solution:

Borax	2 ounces
Water	1 quart

The water should be lukewarm when mixing. Apply with a sponge, and clean off with warm water, also applied with a sponge. Then shellac with a thin coat of shellac cut with alcohol. Then go over with polish made as follows:

Acetic acid	1 gill
Alcohol	2 gills
Water to make total of 1 quart.	

This should be applied with a sponge, and will give a smooth, handsome surface resembling hand-rubbed polish. When a polished surface is so badly worn that the wood is exposed and dark with dirt, it should first be cleaned with a saturated solution of oxalic acid, which will restore the natural wood color. Follow this with the cleaning solution first given, and then polish as directed.

CORRESPONDENCE.

Our readers are invited to contribute to this department, but no responsibility is assumed for the opinions expressed in these communications.

Letters for this department should be addressed to Editor of Amateur Work, 85 Water Street, Boston.

They should be plainly written on only one side of the paper, with a top margin of one inch and side margins of one-half inch.

The name and address of the writer must be given, but will not be used, if so requested.

Enclose stamps, if an answer is desired.

In referring to other letters, give the number of the letter referred to, and the date published.

Illustrate the subject when possible by a drawing or photograph with dimensions.

Readers who desire to purchase articles not advertised in our columns will be furnished the addresses of dealers or manufacturers, if stamp is enclosed with request.

(No. 3.) Brookline, Mass., Jan. 8, 1902.

To the Editor: Our residence is equipped with electric gas-lighting burners. These do not work well. Will you please advise me what I can do to get better service, and greatly oblige. Yours truly, J. P. H.

In this letter, as with many others we receive, there is an absence of particulars, making it difficult to give a satisfactory answer. Correspondents should send sufficient details, so that a proper answer can be given.

If the trouble with the burners is local, that is, some work and others do not, the sparking terminals may have become bent with use and simply need to be adjusted, so as to give a better spark, or a spark that will pass through the gas when turned on. If no spark can be obtained at a particular burner, the wiring is probably broken at some point along or near the fixture. If all the burners are faulty, and a feeble spark or no spark follows when turning on the gas, the battery probably needs renewing, or repairs of some kind. If a Lalcanche cell is used, examine the zincs. If much eaten away, replace with new ones. Also pour out the liquid, and fill each jar three-quarters full with water in which has been dissolved about a quarter pound of sal-ammoniac. If dry batteries are used, replace with new ones.

(No. 4.) Boston, Jan. 5, 1902.

What do astronomers think of Mr. Battell's discovery of the cause of the motions of the planets, published in the papers yesterday? Ignoramus.

Ignoramus: — They do not think about it at all. The "discovery" is one of a very common class of announcements made by persons who, in making them, simply "give themselves away."

"Those things in it which are true are not new, and those that are new are not true."

Such statements are not entertained at all by astronomers.

The accepted explanation of the planetary motions accounts for all the observed facts, and enables these motions to be predicted with very great accuracy. No theory that does not fill these two requirements stands any chance of consideration, especially when, as in the present instance, it is not only unconfirmed by a single observed fact, but in its logical consequences is flatly contradicted by the evidence we have. Vega.

(No. 5.) Waltham, Jan. 9, 1902.

I notice in the paper on drawing instruments, in your first issue, the statement that the hairspring attachment to the large dividers is not popular among professional draftsmen. Will the writer please explain? Among all those I have met, it has been thought a very desirable feature, and its use only prevented by the additional cost, which, at the rates now paid to draftsmen, is practically prohibitive.

If I might make a suggestion as to another matter touched in the same paper, that of pencils, the best I have been able to find are Hardtmuth's "Koh-i-noor." These cost a little more than Faber's, but the difference is not worth consideration, in view of the excellence of the pencils. Draftsman.

Why the hairspring attachment is not more generally used on large dividers I do not know. The reason cited by the correspondent may be the correct one. I find it of great value in my own work, and think draftsmen, generally, would not be without it after once giving it a good trial. Earnest T. Childs.

PROGRESS IN PHOTOGRAPHY.

Frederick A. Draper.

Photography is too often but a passing fad with many who first embrace it with enthusiasm. Various reasons are advanced to account for the diminishing interest that overtakes so many who start with the brightest of prospects. That it is "expensive" is admitted, where any and all kinds of views are taken, often only to gratify a momentary whim. That it can be made a pleasing and permanent recreation with incidental profit is also a fact, though this may not be generally known by those who have failed. If one will only consider the causes which have contributed to both success and failure and utilize this information, many mistakes will be avoided, and success be more easily achieved. Those who contemplate riding this fascinating hobby will likewise benefit if they but follow the injunction to "look before you leap."

The failure to do good work is the rock that

wrecks many an enthusiastic beginner. The finished print is the objective end in photographic work. All the work of focusing, exposing, developing, and printing is here finally shown. This requires that each stage should receive due care. Carelessness or error in one part will surely mar the final result. Satisfactory work can only follow close attention to all details, until experience has shown which is the correct process. This means study and application, especially during the early attempts, and care always. This method of work, however, soon proves its value in the better and more valuable results achieved. When high-grade work becomes the rule and not an accident, then the item of "expense" no longer prevents the enjoyment of photography.

This period of apprenticeship and of study necessary to becoming an artist should be worked out with good and suitable tools. Beginning with the plates, and omitting all question of the brand, the matter of speed is one that receives, from the beginner at least, very little thought. "Instantaneous" is the one kind used, whether suitable or not and "orthochromatic" plates are almost an unknown quantity. The result cannot be satisfactory.

The day, the view, the exposure, the kind of print, all influence the problem of selecting the plate, and the one chosen should be that most likely to produce the desired result. The testing of new kinds should progress slowly, however, and, preferably, those from the same maker should be used until their action is well understood. An instructive experiment is that of taking the same view with time, instantaneous, orthochromatic, and backed plates, and then, with these negatives, printing on various kinds of paper.

The differences in the intensity of light requires study, especially when indoor work is attempted. A familiarity with this important matter will materially lessen the number of failures. The use of an actinometer should be learned, and it should be utilized for about all indoor work. One that will answer for most purposes can easily be made. How to make and use one will be the subject of another paper soon to be presented in these columns.

The variations in the developer should be limited to the least number that will properly provide for the range of work being done. One which is of medium speed and easily controlled is most suitable for the beginner. One-solution developers are largely advertised and possess some good points, but for a wide range of work two-solution developers will be more satisfactory. The particular kind of work in hand and the kind of print to be made regulate the make-up of the developer. For storing the various solutions, choose a bottle of a size that will just contain the quantity on hand, so no air space will be left in the top. Use rubber stoppers. The air in a half-empty bottle will so affect some solutions as to make them useless.

Printing papers are now so numerous and in such variety as to afford ample opportunity for developing the artistic possibilities of a negative to the utmost. The gas-light papers make evening work a delight and enable the daytime leisure to be used in view taking.

Enlargements are a feature that the novice generally is anxious to attempt. Here again the question of light must be carefully studied, not only as applied to the whole plate, but also to different parts of the same plate. "The intensity of the illumination varies inversely as the square of the distance from the source of light." That is, if a certain negative one foot from the light requires five seconds' exposure, at two feet it would require twenty seconds. Correct focusing is also important. The light should be of large area with a large reflector, and negative and paper should be perpendicular and accurately placed to secure even definition. The distance between light and negative varies to suit the necessities of the negative.

Enlarged negatives are now receiving much attention by progressive amateurs, the claim being that the contact prints secured from such negatives are much more satisfactory than paper enlargements. A paper plate recently placed on the market would seem to be particularly adapted to this work, the cost being much less than for glass plates.

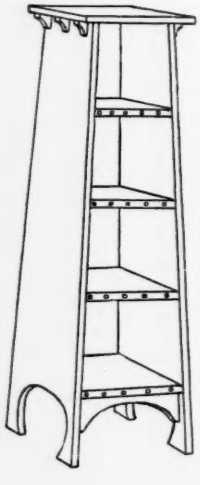
As an example of how some income may be secured from photographic work, the experience of an acquaintance of the writer is here given. He started with the usual 4 x 5 camera, acquired some experience, but soon found that the small pictures were in but little demand. A 6½ x 8½ was the next acquisition. He soon had a small collection of negatives of some fine bits of scenery in his neighborhood, also a few of the public buildings, etc. Prints were made in a variety of tones,

mounted on mats of suitable shades, on which calendar pads were fastened. With the assistance of a friend, whose store was well located, he secured a large sale. One manufacturing company took several hundred and had a neat card printed in one corner, the size of the calendar being reduced to allow it. He is now preparing to do a good business with summer tourists, a sample frame with business card being hung in several of the hotels to attract attention. What he has done can be duplicated in hundreds of places throughout the country. The professional photographer in the smaller places very rarely develops local possibilities of this kind, or, if he attempts it, makes poor work of it, so does not require consideration in this field. Artistic views will always meet with a good sale, and our readers will secure satisfactory returns if they can do work good enough to secure the patronage of the public.

OLD DUTCH FURNITURE.

JOHN F. ADAMS.

IV. MAGAZINE CABINET.



THIS very convenient piece of furniture is easily made. All the stock, except the top piece, is selected oak, $\frac{3}{4}''$ thick. The top piece may be of the same thickness, but will look better if 1″ thick. The two side pieces are $42\frac{1}{2}''$ long, $9\frac{1}{2}''$ wide at the top, and 14″ wide at the bottom. As pieces this width are not easily obtainable, it may be necessary to glue two pieces together. If the worker is not used to this kind of work, it had best be done at the mill, the charge for doing it not being very much. To get the taper at the top, a triangular piece is taken off of each side, which can also be done at the mill, as well as the sawing out of the circular recess in the bottom of each side, the two pieces that go under the lower shelf, and the brackets under the top. All edges should be planed smooth, as the cabinet is open on both front and back. The side pieces are $12\frac{1}{4}''$ apart at the bottom and $7\frac{3}{4}''$ at the top, inside measurements. The under side of the lower shelf is 6″ from the floor. This shelf is $12\frac{1}{4}''$ long and 12″ wide, allowing $\frac{1}{4}''$ on each end for mortise. On account of the inward slope of the sides, the mortises for all the shelves must be cut at a slight angle. These mortises should be carefully cut to the exact width of the shelves to give a tight fit, so that the cabinet may stand firm when finished. The ends of the shelves must be cut to the same angle as the slope of the sides. To avoid errors, a rough plan may be drawn on the scale of $\frac{1}{4}''$ equals 1″. The shelves are 8″ apart in the clear, the top shelf being about 9″ from the top piece.

The top piece is 14″ square and 1″ thick, and is fastened to the side pieces by screws, three for each side. It will probably simplify the work if the top and lower shelf are fastened to the sides before sawing out the other shelves, all the mortises having previously been made. The second shelf is $11\frac{1}{2}''$ long and 11″ wide. The third shelf is $10\frac{1}{2}''$ long and 10″ wide. The top shelf is $9\frac{1}{2}''$ long and 9″ wide. The shelves are fastened to the sides by screws from the outside, the heads being countersunk into the wood and covered with putty. Screws of small diameter should be used, so that the holes for them will be as small as possible.

The shelves not being so wide as the side pieces will not quite cover the mortises. The little spaces left outside the shelves should be filled with small pieces of oak glued in. If each piece is clamped when put in, the glue will hold better and cracks will be less conspicuous. Fill all cracks with putty.

The two pieces under the lower shelf are 12″ long and 3″ wide. The arches are 2′ deep, making the pieces 1″ wide at the center. These are fastened by screws, using care not to split the pieces when putting them in. They are set 1′ inside the edge of the shelf, the outside ends being cut to the angle of the sides. The three brackets on each side of the top are cut from pieces $2\frac{1}{2}''$ square and $\frac{3}{4}''$ thick. Make a paper pattern and have them sawed out at the mill. These are fastened by one screw in each, in addition to being glued. The inside edge must also be cut at the same angle as the side pieces.

When done, sandpaper smooth and stain a very dark brown or green. The edges of the shelves may be covered with a leather border nailed on with square head upholstering nails.